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Board product and method for making the same

The invention relates to a coated board product and its production.

An object of the invention is to improve the quality of board products, especially boxboard, and the economy of producing the same.

Board is required to have a certain surface quality for ensuring a desired gloss and print quality, a stiffness and tear resistance for securing the functionality of a package. Since board is produced in large quantities in a board mill, the efficient use of raw material is also important. The demands are somewhat contradictory to each other. Board can be provided with a sufficient gloss by calendering the board by compressing it in a nip, often moistened and heated in a certain manner. The surface fibers and coating of board are preferably pressed smooth by this compression, yet without compacting the middle ply of board. The compaction of a middle ply undermines board stiffness and reduces tear resistance. The compaction of a middle ply is often referred to as a loss of bulk. In this case, bulk is understood as being an inverse value to density and a loss thereof is thus equal to a densifying compaction of paper or board.

Since the process of making paper and board is highly raw material intensive, even a minor saving in raw material provides a major advantage over competitors. In this respect, a saving of just one percent can be considered a major competitive edge and the investment restitution time is short. Saving raw material is also desirable for environmental reasons. By virtue of a reduced weight structure, the multiplicative effects of the board of this invention cover the product's entire life span, the reduced consumption of raw material resulting in a lighter container which ultimately creates savings also in shipping operations and in the way of a reduced amount of waste.

Packing boards are often coated and have a multi-ply structure. Coating and sizing are used for providing desired properties. A typical surface density range for folding boxboards is 180-350 g/m^2. The necessary surface density depends on a required stiffness of the package, a lighter board being sufficient for small boxes. Successful conservation of board bulk in surface treatment to produce thereby board of a higher stiffness results in savings of raw material and energy by enabling the use of board of a lesser surface density. Typical applications for board include cigarette packages, pharmaceutical packages, postcards, cardboard covers for books, various food packages.

Folding boxboards are often smoothed prior to coating with a Yankee cylinder, which enables a good bulk and stiffness, the surface properties being also good, the drying shrinkage along the edges being likewise small, yet the use of a Yankee cylinder is limited by speed restraint, space demand for equipment and the enormous size of a Yankee cylinder in a high-speed machine. Another typical treatment method involves a wet-stack calender, the drawbacks of which include problems regarding runnability and a controlled application of water and, in addition, extra costs are incurred by the necessity of drying the board before and after a calendering process.

A machine calender is often used together with other calenders, the machine calender referring to a hard calender with no elasticity in its rolls. The use of a machine calender as the sole surface treatment method is not advisable. A soft calender refers to a soft-nip calender, wherein the calender roll has a surface which is elastic, the surface having possibly a hardness in the same order as the surface hardness of wood, yet being elastic.

It is an object of this invention to provide a smooth printing surface, a high gloss and stiffness in boxboard with a lesser-than-before consumption of material and to avoid bottlenecks and improve runnability with a method of

the invention. This object is accomplished with a packing board as set forth in claim 1. The coated packing board of the invention comprises two or more fiber plies, wherein the outside plies consist of bleached chemical pulp and the middle plies of mechanical pulp or chemithermo-mechanical pulp, recycled paper pulp, recycled cardboard pulp or broke. The body consists typically of recycled mixed pulp, the body and the top surface having therebetween a protective ply which typically consists of deinked pulp (DIP), white ledger, chemithermo-mechanical pulp (CTMP) or mechanical pulp (GW). The middle ply may have a core which consists for example of old corrugated containers (OCC), mixed waste paper pulp (MW), old newspapers (ONP), groundwood (SGW, PGW) or broke. The backing comprises for example bleached chemical pulp or chemithermo-mechanical pulp. In any case, the purpose of a multi-ply structure is to create a surface with good printing qualities, a dark recycled material being good enough for the middle ply. A typical surface density range is 200-400 g/m². The structure of a typical boxboard is illustrated in fig. 4.

Generally, the pretreatment of a boxboard surface prior to a coating process is performed with a machine calender and/or a Yankee cylinder. The function of a machine calender is to provide the web with a uniform thickness profile. Smoothing of the surface is performed with a Yankee cylinder.

According to the invention, boxboard is treated with a long-nip calender prior to coating in order to upgrade the board qualities over what is known before and, in addition, the production runnability is improved and the production method is not subject to a speed restraint the same way as a Yankee cylinder. A long-nip calender suitable for making a board of the invention has been described for example in the Applicant's earlier patent US6164198.

The operation of a long-nip calender suitable for calendering a board of the invention will now be described with reference to the figures

Fig. 1 is a sectional view of a long-nip calender, provided with an extended nip between an enclosed shoe calender and a counter roll.

Fig. 1A is a partial enlargement of fig. 1.

Fig. 2A is a partial sectional view of the device shown in fig. 1, along the roll axis and depicting a drive mechanism.

Fig. 2B shows the operation of press shoes in a longitudinal section.

Fig. 3 shows measuring results for test parcels in graphic representation.

Fig. 4 shows the structure of a typical boxboard in a schematic view.

A calender suitable for the surface treatment of a board of the invention is shown in figs. 1-2 to include a fixed support element 14, around which is a tubular jacket 12. A heated counter element 22 is disposed on the other side of the tubular jacket 12 from the support element, such that a web passes through between said counter element and the tubular jacket. The fixed support element is provided with load elements 18, 20, applying the jacket 12 against the heated counter element 22 and thereby enabling a calendering process between the jacket and the counter element. The jacket has its opposite ends secured to end walls 24, 26 mounted rotatably relative to the support element, the rotary motion of the end walls being delivered by a separate drive motor, which is independent of a motion of the fiber web in order to avoid overheating of the jacket. The drive motor is shown in the figure in dashed lines.

A method of the invention for conditioning the surface of coated or uncoated board with a surface conditioning device is in turn characterized in that the method comprises feeding a fiber web through an extended nip established by a roll and a counter-roll, the former being in the form of a tubular-shaped flexible jacket. Across the extent of the nip the jacket deflects and thereby presses into contact with the counter-roll over a long stretch. The board treated with the method is lighter than currently available boards, while stiffness and surface properties are equal to those of currently available boards.

The solution enables a running speed substantially higher than what is accomplished with a Yankee-cylinder equipped board machine. In addition, the runnability is better, this also contributing to improved quality and reducing waste.

Web speed in the calender may be higher than 600m/min, preferably higher than 800m/min, and still more preferably 1000 m/min, and even as high as about 4000 m/min. Thus, the calender does not restrict the speed of a board machine. The above-mentioned heated roll has a temperature of 150-350°C, preferably higher than 170°C, most preferably about 200-250°C. Linear pressure in the nip is within the range of 100-500 kN/m, preferably less than 400, most preferably about 50-300 kN/m. Maximum pressure in the nip is 3-15 MPa, preferably less than 13 MPa, most preferably about 0,5-8 MPa.

In fig. 1, a board web 80 travels through an extended and heated nip 1. The nip 1 is established by means of an enclosed shoe roll 10 present under the web 80. Above the web 80 is a heatable counter-roll 22. The enclosed shoe roll 10 comprises a flexible jacket 12 impervious to liquid. The jacket consists for example of fiber-reinforced polyurethane. The stationary fixed support element 14 carries at least one load shoe 18. Between the load shoe 18 and the support element is an actuator 20, such as a hydraulic cylinder, for

urging the concave load shoe 18 and thereby also the flexible jacket 12 against the counter-roll 22. Thus, the jacket 12 is forced out of its normal unloaded position 11 in a direction away from the center of the enclosed shoe roll. The jacket 12 is fastened at both ends thereof to end walls 24, 26, thus creating a sealed compartment 13 (see fig. 2). As shown also in fig. 1, at least one detector device 99 is mounted in communication with the web 80 for detecting web breaks. The detector device 99 is connected to a control device 98 for controlling the operation of a calendering process in dependence of the web being broken or not.

As shown in fig. 1, the heatable counter-roll 22 is accompanied by a disengagement mechanism, comprising a lever 95 pivotable by means of a hydraulic cylinder assembly 94 and provided with a pivot point 96 for pivoting the lever thereon. The disengagement mechanism presses the counter-roll 22 to an engagement with the nip 1 and disengages it from the nip 1.

Between the load shoe 18 and the jacket 12 is supplied a pressurized oil, which develops a hydrostatic pressure throughout the nip and presses the jacket to an engagement with the counter-roll 22 over the entire extent of the nip 1. At the same time, the oil protects the jacket from being damaged by lumps and a temperature rise.

In fig. 2A it is shown that the end walls 24, 26 are rotatably mounted on stub shafts 16, 17 of the support element 14. (The end walls are preferably not integral but divided into a static part and a rotating part as shown in fig. 2B). On one end of the stub shaft, a cylindrical shaft 32 is arranged rotatably via bearings 34. A support column 36 is arranged to the cylindrical shaft via self-aligning bearings 38, which allow spherical movement to allow the deformation/bending of the support element 14 when heavily loaded. One of the end walls 24 is fixedly attached to the cylindrical shaft. A drive

transmission 40 is fixedly attached to the cylindrical shaft outside the end wall, in the shown embodiment a cog wheel. The cog wheel is connected to a transmission 42 and in turn a drive 44. A cog wheel 46 is fixedly attached to the cylindrical shaft inside the end wall. A drive shaft 48 is arranged inside the jacket and parallel to the support element 14. The drive shaft 48 is supported by bearings 50 arranged in bearing houses 52 attached to the support element. At each end of the drive shaft, cog wheels 54 are arranged. Preferably these cog wheels have a prolonged toothed portion to allow axial movement of the intermeshing cog wheel which is attached to the end wall. A further cog wheel 56 is fixedly attached to the second end wall 26 inside the jacket. Both cog wheels inside the jacket mesh with the corresponding cog wheel on the drive shaft. The second end wall 26 is rotatably arranged on the second stub shaft 17. The second stub shaft is in turn fixedly attached to a second support column 58.

The operation is as follows. During normal operation, the driven heated roll 22 is in interaction with the fiber web and the flexible jacket 12 by means of a desired pressure being exerted by the load shoe 18, thereby causing a friction based drive of both the fiber web and the flexible jacket. Accordingly, during normal operation the forces exerted in the nip provide for rotation of the enclosed shoe roll.

Only in specific occasions, it will normally be desirable to operate the independent drive of the enclosed shoe roll 10, for example when starting up the calender. If the calender should be started without first speeding up the flexible jacket 12, this would inevitably cause damage to the flexible jacket due to overheating. Furthermore, it would also be deteriorating for the fiber web, since at the moment of start it would develop exceptional tension forces in the fiber web. Accordingly, the independent drive arrangement of the enclosed shoe roll is to be used for instance at the start-up of the calendering surface. At the start, the nip gap is not closed, but the roll 22

has been moved out of contact with the nip 1. Before moving the heated counter-roll 22 into the nip, the drive arrangement 44 of the enclosed shoe roll 10 is activated to accelerate the first end wall 24 via transmissions. The rotation of the end wall causes the inner first cog wheel 46 to rotate, and subsequently the drive shaft 48. The drive shaft transmits the rotation to the second end wall 26 via the second inner cog wheel 56. The both end walls are thus accelerated and rotate at the same speed until a desired peripheral speed is obtained, which is normally equal to the speed of the fiber web. The nip is closed by activating the hydraulic piston 94 to pivot the lever 95 and thereby moving the counter-roll 22 into the nip and subsequently the load shoe 18 is urged against the heated roll 22 by means of its actuators 20. Once the calender functions in the desired manner, the drive arrangement of the enclosed shoe roll can be deactivated and the press roll driven in a conventional manner by means of friction within the nip 1.

In fig. 2B there is shown an alternative embodiment of the drive arrangement for an enclosed shoe roll. This embodiment uses friction for the transmission of rotational forces.

Fig. 2B also shows a more preferred design of arranging the support element and the end walls. The end walls are divided into an inner part 24A; 26A connected non-rotatably to the support element 14, a rotational part 24B; 26B, and a bearing assembly 24C; 26C therebetween. The support element 14 is at its ends arranged with self-aligning bearings 23, 25 to allow a deflection of the support element 14.

In the figure there is shown a drive 44 having a shaft 19B. On the shaft 19B is mounted a disc 19 having a rubber layer at its peripheral end 19A. The outer ends of the flexible jacket 12 are fixedly attached between an annular ring 15, acting as a replaceable force transmitting device, and the periphery of each end wall. The ring 15 is fixedly attached to the end wall. On the

inside of the rotational part 24B, 26B of each end wall there is fixedly attached a cog wheel 46, 56. The drive arrangement 44, 19 is movable in and out of contact with the force transmitting device 15. When it is desired to accelerate the enclosed shoe roll 10, the drive arrangement is moved such that the rubber layer 19A comes into frictional engagement with the force transmitting device 15. The cog wheel 46 and the drive shaft 48 transmit the rotation of the end wall 24 to the other end wall 26 by means of the cog wheels 54, 55 and 56, which at the same time function as a synchronizing device. Hence, both end walls 24, 26 are operated as described in reference to fig. 2A. Fig. 2B further illustrates in a schematic view one preferred functional embodiment of the load shoe 18. As a rule, the load shoe 18 is not disposed diametrally relative to the drive shaft, but perpendicularly as in fig. 2A.

Tests indicated that, in test batches manufactured by means of a long-nip calender as described above, the board could be provided with a ratio of bulk and smoothness better than in currently available types of board. Thus, according to measurements, the object of the invention is well fulfilled.

Shoe calenders can be driven at notoriously high speeds and, furthermore, by the application of an elevated temperature, e.g. about 250°C, and by taking into account a long dwell time in the calendering zone, the resulting gloss finish will be equal to what is achieved in a slower solution using a Yankee cylinder. In addition, the board is provided with improved bulk. In addition to aspects contributing directly to board quality, the results include savings of production space in a mill, the elimination of a production limiting Yankee cylinder, and the provision of a more manageable, more easily controlled system.

In view of producing board of the invention, it is preferred that surface moistening be provided prior to calendering. However, the inventive board can also be produced without surface moistening.

Pilot tests were conducted for comparing a board manufactured on a normal Yankee cylinder with a board produced with the same machine, which was not smoothed by means of a Yankee cylinder but which was calendered in pilot conditions by a shoe calender as described above. As a reference, the same board was also calendered with a soft calender.

The enclosed figure 3 illustrates the ratio of Bendtsen roughness to obtained bulk. The grades treated by means of a shoe calender are designated with the word shoe, those manufactured by means of a soft-nip calender with the word soft. The degrees refer to a calendering temperature and the symbol reference is used to refer to a grade of board manufactured with a Yankee cylinder. A clear trend is observed, according to which the majority of results measured on a shoe calender lies within a high bulk and smooth range, Bendtsen roughness is about 500 ml/min or less, while bulk is more than 1,40. The board smoothed with a Yankee cylinder is smooth in terms of roughness, about 300 ml/min, but its bulk is only in the order of 1,29. It should be kept in mind that the question is about results obtained in pilot conditions, the experience indicating that the results improve in production conditions.

The measurements relate to precalendering results prior to coating. After a coating process, the method is capable of producing board, which has a surface density of 150-500 g/m^2, PPS-s10 roughness (ISO8791-4) 0,8 - 3,0 µm, Hunter gloss (ISO/DIS 8254) 30-80%, and a density (SCAN-P7:75) of 500-1000 kg/m^3.

Compared with prior known grades, the obtained board is higher in bulk and smooth and, in addition, the production method is not speed restricted the same way as a Yankee cylinder. The method provides saving in board manufacture and improves economy. Especially, the increase of capacity is possible with the same board machine by on-line calendering. In the case of a new mill, space is also saved in comparison with a Yankee cylinder. The provision of higher bulk represents a direct saving in terms of the amount of material and energy needed for production, the lighter packing board saving likewise energy over its service life and ultimately producing less waste.